Seabed Variability and Its Influence on Acoustic Prediction Uncertainty

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LONG-TERM GOALS

Assess and mitigate uncertainty in the tactical naval environment, in terms of accurate acoustic detection with specific reference to geoacoustics through two overarching goals:

1. Assess and characterize seafloor variability in shelf environments
2. Determine the impact of the seafloor variability on acoustic prediction uncertainty.

OBJECTIVES

1) Determine the uncertainty related to the natural variability in the environmental parameters that drive the modular modeling approach of ***2D-SedFlux*** (primitive geological parameters). These include ocean climate and the sediment supply to the ocean margin from land. Of interest is how this variability couples with, or is independent of, model error (numerical, prediction-precision, and accuracy), in terms of local and regional characterization of uncertainty of properties of seafloor of continental margins.

2) Provide ***2D-SedFlux*** realizations in areas of interest to the seafloor geoacoustic team (Pratson, Holland). These realizations provide the sampling field from which Goff will sample via Monte Carlo or other statistical techniques in order to conduct uncertainty experiments. The realizations provide data sets for seismic convolution experiments (Pratson), inverse experiments (Holland), propagation experiments (Odom) and reverberation experiments (LePage). Convolve the ***SedFlux*** output with known calibrated source signatures, for studies of attenuation and scattering. ***SedFlux*** runs provide information on seafloor layering (bed coherency, bed attributes), likely location of sub-seafloor gas, proxies of seafloor roughness (ripples vs. sediment waves), and high porosity vs. low porosity zones.

3) Introduce the concept of uncertainty to the ONR-Geoclutter Modeling group to provide information on uncertainty related to false-target acquisition to our seafloor geoacoustic team. This effort would explore seafloor uncertainty related to the estimate of the location of buried channels, morphology and orientation of these channels.

4) Determine which continental margins, presently of interest to the operational Navy, would/could experience seasonal or inter-annual changes in the nature of its seafloor properties through the impact of events (earthquakes, ocean storms, river floods).

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APPROACH

1) Using MODAS and other ocean data, and ***Hydrotrend*** discharge predictions, characterize the natural variability of the environmental forcing functions controlling the seabed at the selected sites.

2) Conduct a series of ***SedFlux*** realizations of seafloor attributes that captures the natural variability of the modern climatology, and then show how the seafloor properties would change under climate change scenarios (wetter, drier, hotter, colder). Here the emphasis is on both spatial and temporal changes in the seafloor properties.

3) Provide to the geoacoustic team, 3D numerically derived data that characterize a margin like the New Jersey margin, and where buried channels (sandy in a mud matrix, or muddy in a sand matrix), or surface bedforms, may dominate the sub-seafloor acoustic response.

4) Using SedFlux, conduct experiments to determine the impact of single events (e.g. a large 100yr flood) on the seafloor characteristics. Determine the magnitude of the change in the seafloor character, and develop a method to provide this information in some probability density function. (This set of experiments targets continental margins of the type commonly found around China, S.E. Asia, Korea, etc).

WORK COMPLETED

This project is in its very early phase. Work completed includes recoding the numerical model ***HydroTrend*** so that it is able to predict the sediment delievery to the world coastlines in a more operational manner. The previous method relied on being able to estimate the rating coefficients for the different water sources (snow and ice melt, groundwater, etc). The new method uses an algorithm based on more universally accessible drainage basin properties (soil thickness, relief, temperature, etc) and reduces model uncertainty by reducing the number of tuneable parameters. The ***SedFlux*** model has been upgraded to employ Monte Carlo sampling of the probability density distributions produced from ***HydroTrend*** simulations. Once operational, we will test the various ‘type’ littoral zones for their sensitivity to ocean and river storms impacting seafloor properties. A schema is being developed to track the uncertainty of model results due to a) environmental input parameters, and b) model resolution and boundary conditions. A beta version of *SedFlux* now predicts the geoacoustic attributes of the seafloor simulations, needed for later full convolution with acoustic source signatures.

RESULTS

This project is in its very early phase.

IMPACT/APPLICATIONS

New numerical tools are being refined to allow for predicting the general nature of seafloor morphology and the developing sediment stratigraphy. The tools are being refined to allow for simulations in the littoral zone. The tools are being coupled to acoustic models and used to assess acoustic reverberation and propagation. Because these tools are driven by environmental data they offer the promise to provide seafloor acoustical information of continental margins at the global level.

RELATED PROJECTS

ONR Geoclutter: Predicting the Distribution and Properties of Buried Submarine Topography on Continental Shelves

ONR Mine Burial: Sediment Flux to the Coastal Zone: Predictions for the Navy

ONR EuroSTRATAFORM: Modeling the Effect of Climatic and Human Impacts on Margin Sedimentation

NSF MARGINS: Experimental and Theoretical Study of Linked Sedimentary Systems

NSF MARGINS: Community Sedimentary Model Science Plan for Sedimentology and Stratigraphy.

PUBLICATIONS

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